

Technology for Rapid Product Development



Joint Technology Exchange Group
U.S. Coast Guard, Elizabeth City, NC



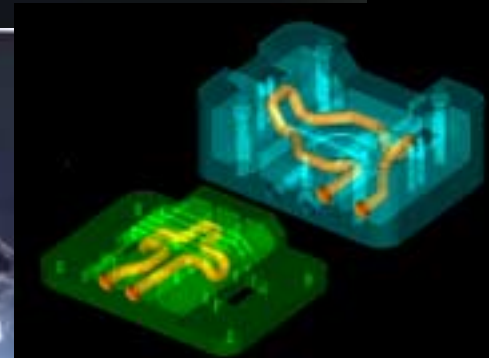
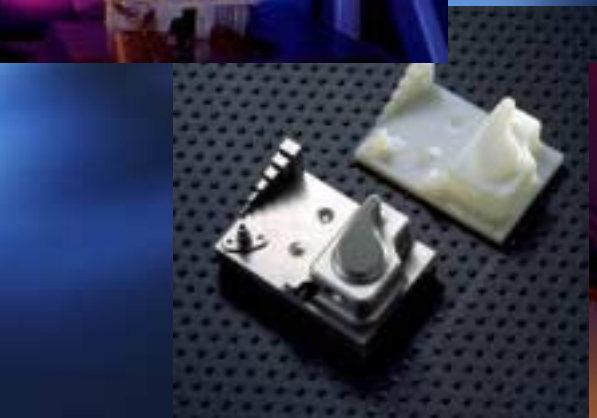
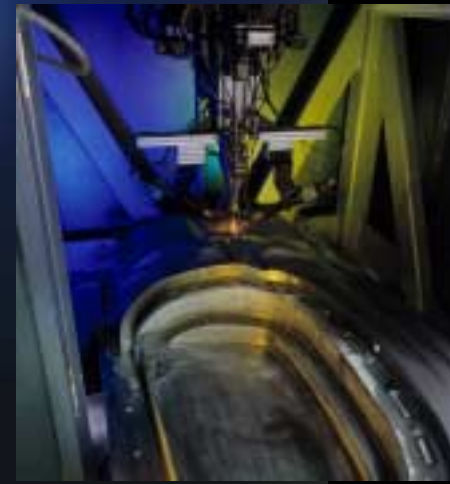
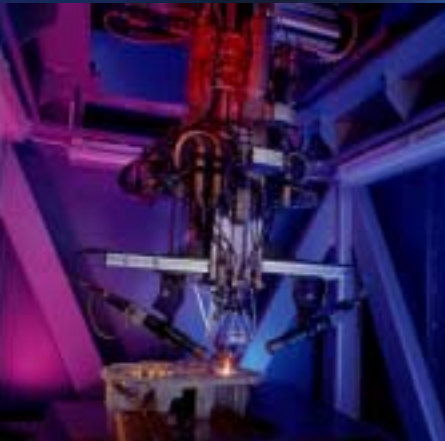
Meeting Objectives

- POM overview
- Technical overview: direct metal deposition technology
- Technology cost comparison
- Future direction





Direct Metal Deposition





Who Are We?

- **POM is a product development service bureau & supplier of DMD technology whose purpose is to:**
 - **Commercialize** new metal fabrication technology (direct metal deposition-DMD)
 - **Provide engineering services** to demonstrate the benefits of DMD technology
 - **Supply production DMD equipment** and ancillary peripherals associated with tooling fabrication, reconfiguration & restoration



What Markets Does DMD Technology Add Value?

Plastics & Metal Manufacturing Industries

Size of Plastics/Metals Market = 963 Billion

(Dept. of Commerce 1996 Survey on Manufacturing)



Key Markets for DMD

- Car & Truck Parts
- Athletic Footwear
- Medical Implants
- Toys & Sporting Goods
- Packaging
- Electrical and Electronic Goods
- Medical Products
- Appliances
- Defense (Navy, Air Force, Army, Ballistic Missile Defense)

Current DMD Clients





What Is This New Technology?

DMD : direct metal deposition

What Is DMD?



LASERS

CAD

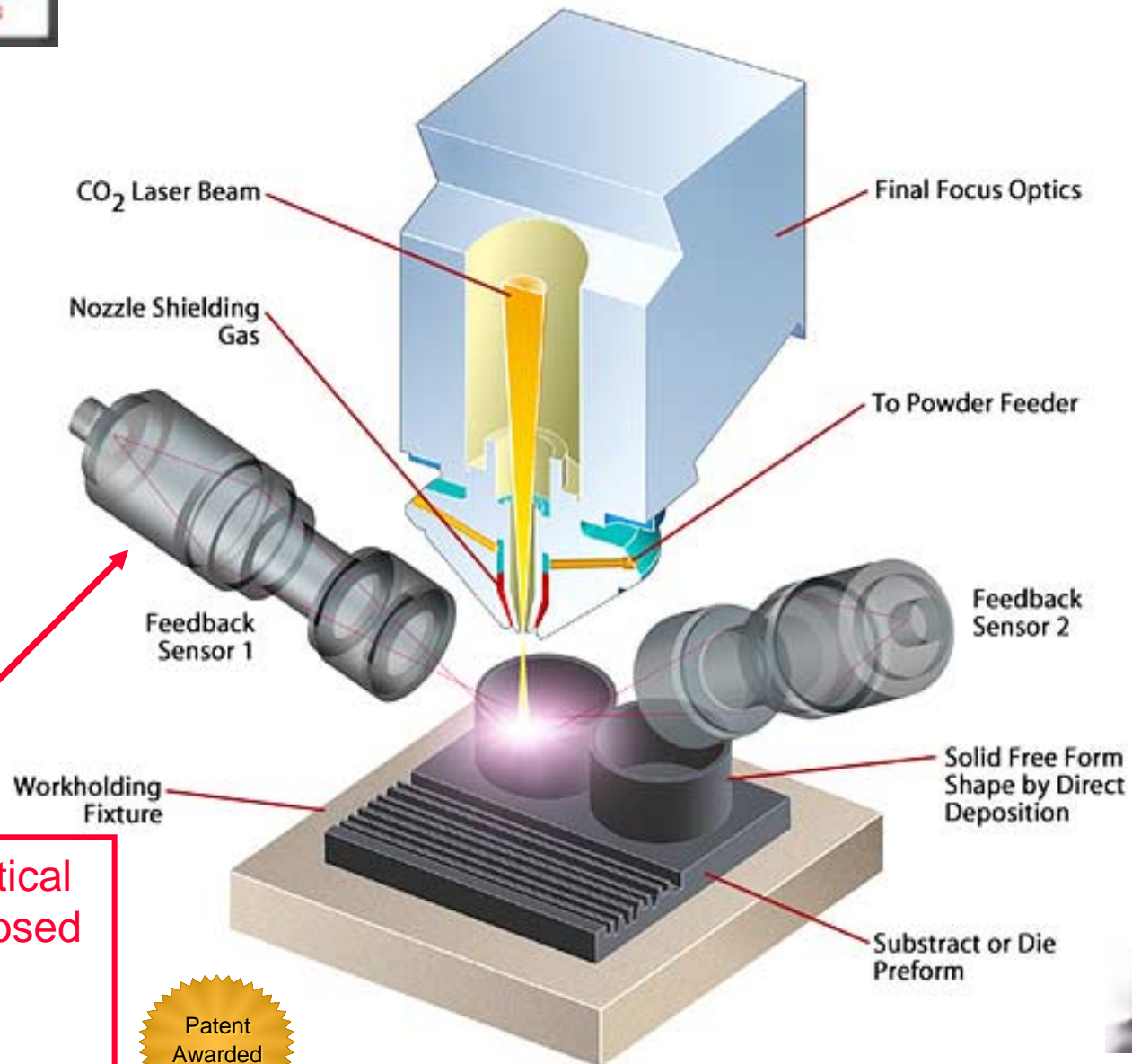
CAM

SENSORS

Patent
Pending

Powder Metallurgy

DMD: *"Blending"* of Five
Common Technologies



DMD used optical sensors for closed loop melt pool control during deposition

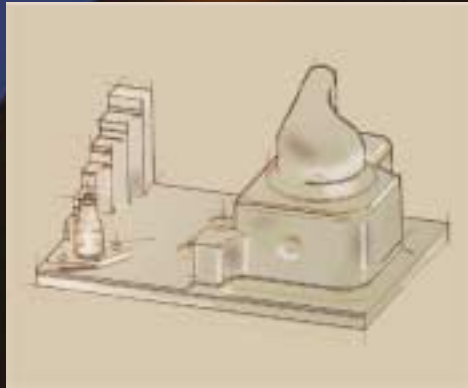
Patent
Awarded



What does
DMD
machinery
look like?



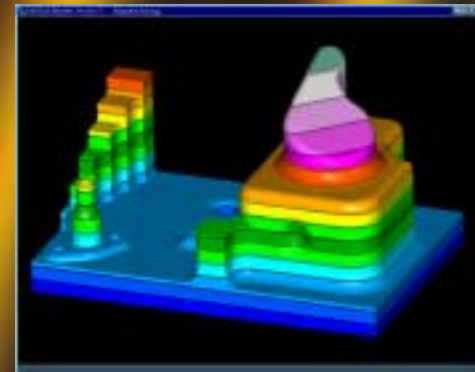
Production Process Steps



Conceptualization



CAD Data Input



CAM Slicing



Production Process Steps



Direct Metal Fabrication



Near Net Shape
Creation to $\pm 0.005''$



Post Finish by CNC/ EDM

How Does DMD's Closed Loop Deposition Process Help?

- Closed loop deposition improves dimensional accuracy...no need for intermediary machining of parts when deposit builds irregularly.



Example of direct metal fabrication with POM's closed loop height controller. Left: w/height controller; Right: no height controller (as used)

How Is DMD Different Than Competing Additive Metal Fabrication Technologies?

- DMD is the only closed loop direct fabrication process; allows for unmanned operation of DMD machinery.
- Closed loop deposition eliminates defects in parts due to tool path overlap errors.
- DMD is the only process to successfully process low melting point and highly reflective materials like pure copper, ceramics and aluminum.





Micro-photograph of “best-in-class” H13 Tool Substrate with H13 over-clad by DMD Process

H13 by DMD

Consistent grain size and hardness due to rapid cooling of laser melt pool during deposition...physical properties are isotropic.

interface



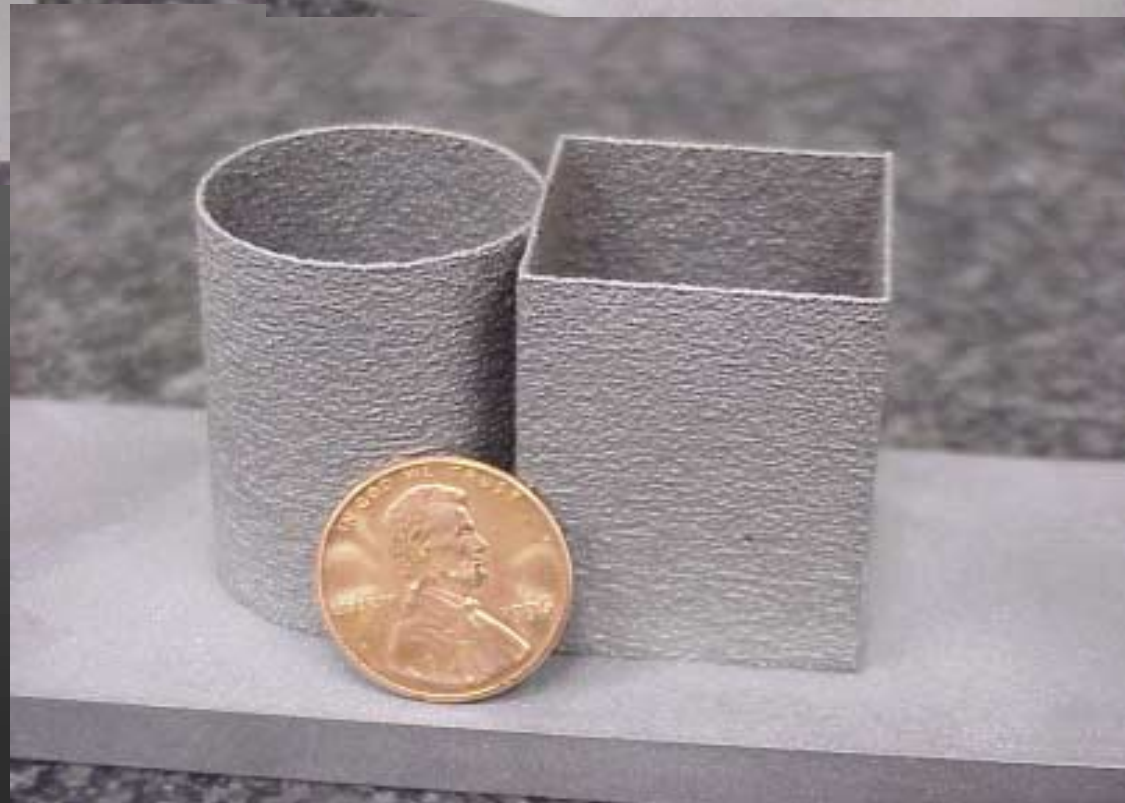
Industry standard H13 mold pre-form

longitudinal
cross-
section

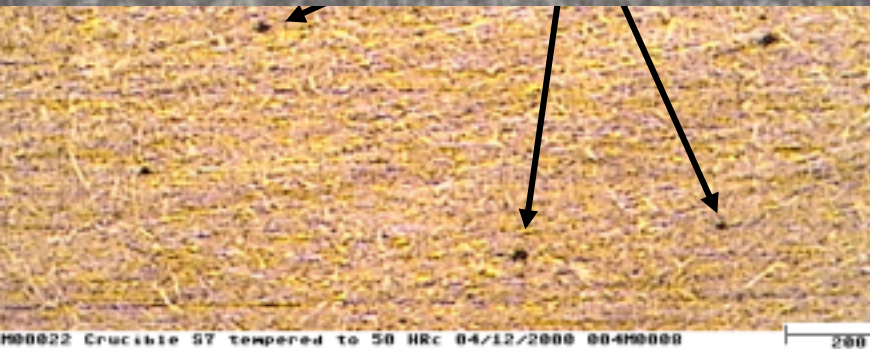
M00017 Matrix Test 90803-1 08/11/1999 908M0018



**DMD Can
Fabricate
Small Detailed
Mold & Part
Components**



Quality of DMD vs “Premium” Cast Metals?



Premium Grade S7 by Crucible
showing non-uniform
microstructure and porosity.





Direct Metal RP

- At present, most prototype parts are manufactured using a SLA process (stereo lithography apparatus) which produces a plastic part directly from a .STL CAD model. In many applications, the prototype parts made of plastic do not meet the application test requirements due to the lack of mechanical and high temperature properties.

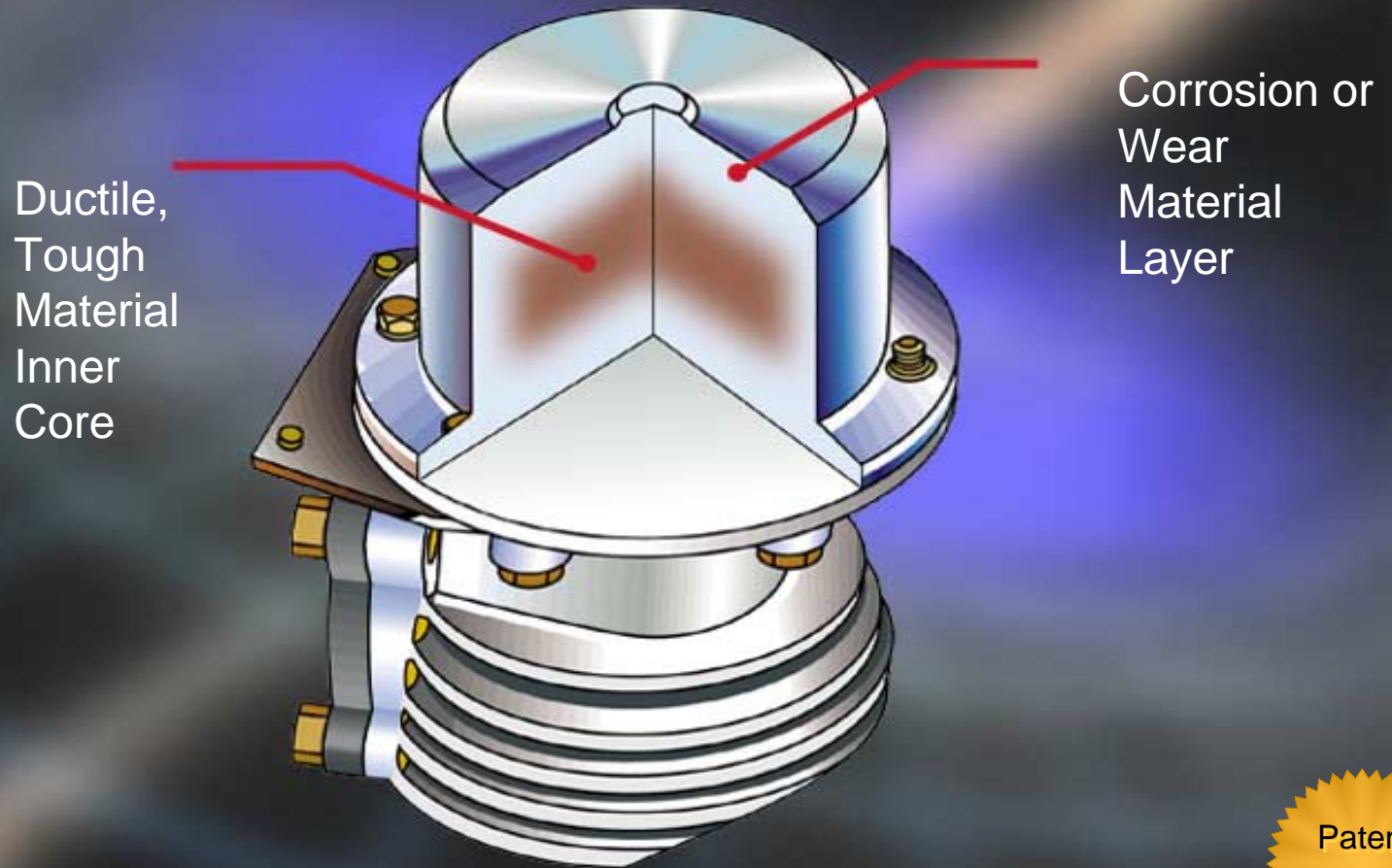
The DMD™ process can be used to produce metal prototype parts directly from a solid model CAD file.

In addition, the DMD process can be used to evaluate the functionality of proposed engineering changes, by adding material to existing aluminum, steel or other metallic parts.

IMS-T1 Benchmark Part (H13 by DMD -vs- SLA)



DMD“smart-parts”

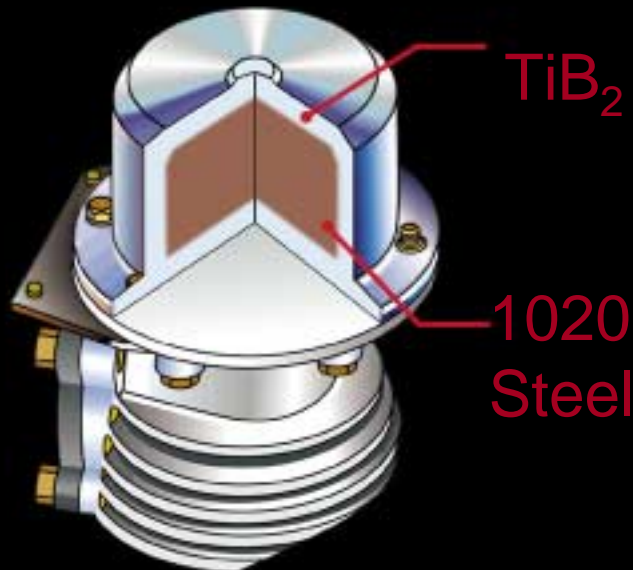


Patent
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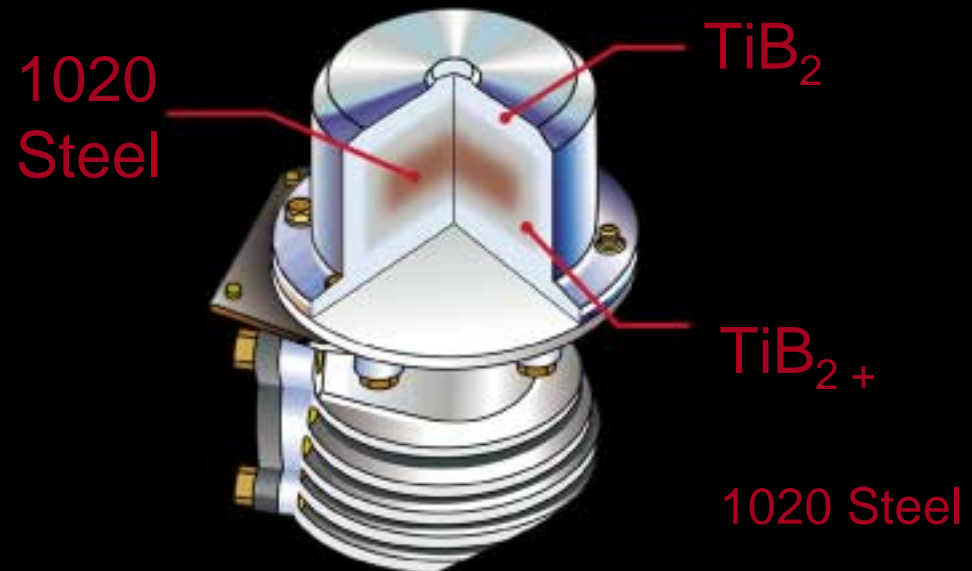


DMD“smart-parts” Hybrid Metal Components

ABRUPT Transition Bi-Metallic Components



GRADED Transition Bi-Metallic Components



Comparisons of Rapid Tooling Processes

DMD: The Only 100% Metal Rapid Tooling Technology

	# of Process Steps	Direct or 2nd Generation	Conformal Cooling	Production or Bridge	Embedded Copper Chills?	Multi-Materials In Same Tool	H13, P20 Tool Steel
KELTOOL	23	second	NO	Bridge	NO	YES, Copper + Nickel	NO, Resin
Selective Laser Sintering (SLS)	11	direct	Line of Sight Only	Bridge	NO	NO	NO
Spray Metal Tooling	11	second	NO	Bridge	NO	NO	NO
ExpressTOOL	12	second	YES	Bridge	NO	YES	NO, Resin
Laser Engineered Net Shaping - LENS	15	direct	Diamond Shape Only	Production	Brass Only	YES, Steel + Brass	YES
Conventional CNC	65	direct	NO	Production	NO	NO	YES
Direct Metal Deposition (DMD)	8	direct	YES	Production	YES, Pure Copper	YES, Tool Steel + Pure Copper	YES

DMD is the only direct art-to-part, multi-material, pure metal production tooling process.



Comparisons of RP Processes

DMD: The Only 100% Metal Art-to-Part Technology

	Cleaning	Postcuring	CNC Finishing	100% Tool Steels
StereoLithographic Apparatus (SLA)	X	X	X	No
Selective Laser Sintering (SLS)			X	No
Fused Deposit Modeling (FDM)	X		X	No
Laminated Object Model (LOM)	X		X	No
Direct Metal Deposition (DMD)			X	Yes

Full Dense Tool Steels

DMD is the only direct art-to-part, multi-material, pure metal rapid prototyping process.

Rapid Tool Costs and Fabrication Lead Time

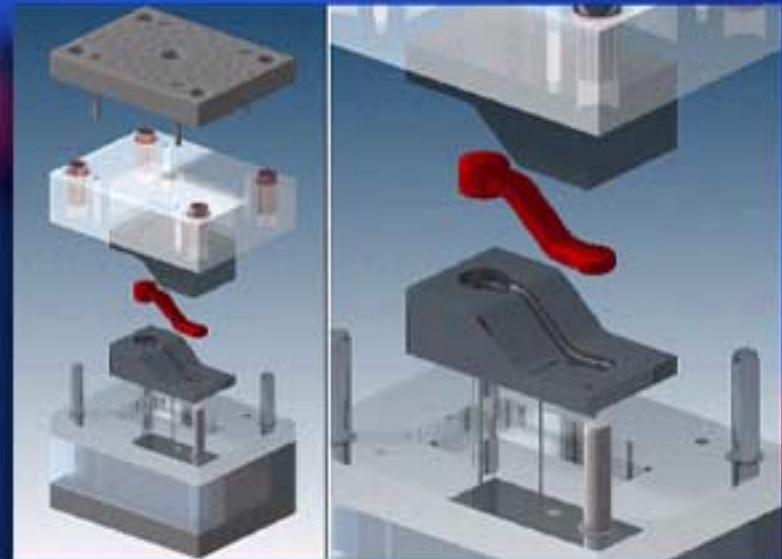
Benchmark Evaluation of RT Technologies

Rapid Tool Vendor	Fabrication Process	Material	Cost (core/cavity)	Lead Time
PCC Structurals	Investment Cast	H13 Steel	\$6,500	6 weeks
SouthCo.	CNC	P20 Steel	\$5,800	4 weeks
Paramount Industries	SLS	RapidSteel 2.0	\$7,570	2.5 weeks
POM	DMD	H13 Steel	\$4,320	1 week
Optomec	LENS	H13 Steel	\$17,400	6-8 weeks
Bastech Engineering	SLS	RapidSteel 2.0	\$5,840	2.5-3.5 weeks
Harcast Co.	Investment Cast	A2	\$5,270	10 weeks

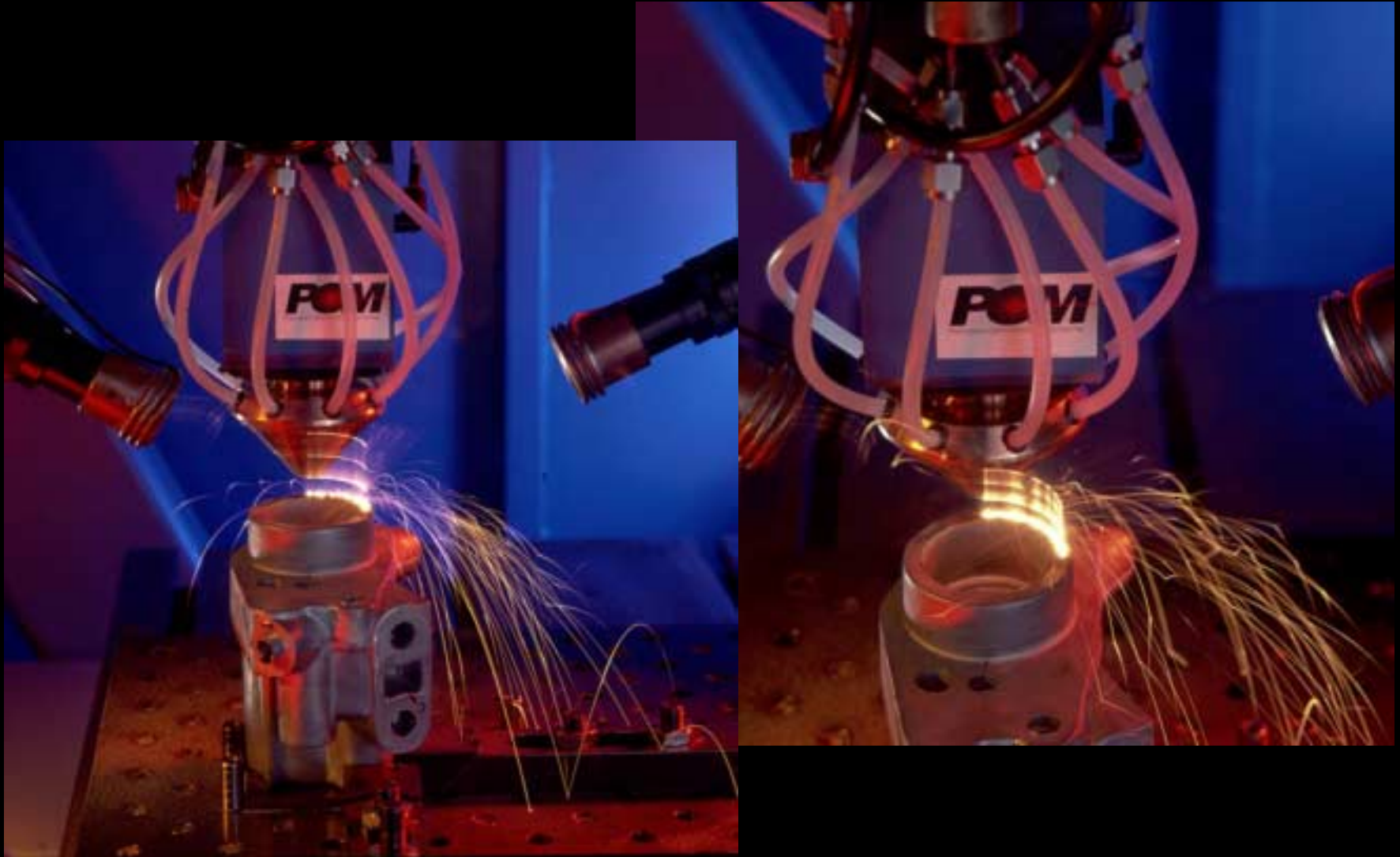


How is the New Technology Best Used ?

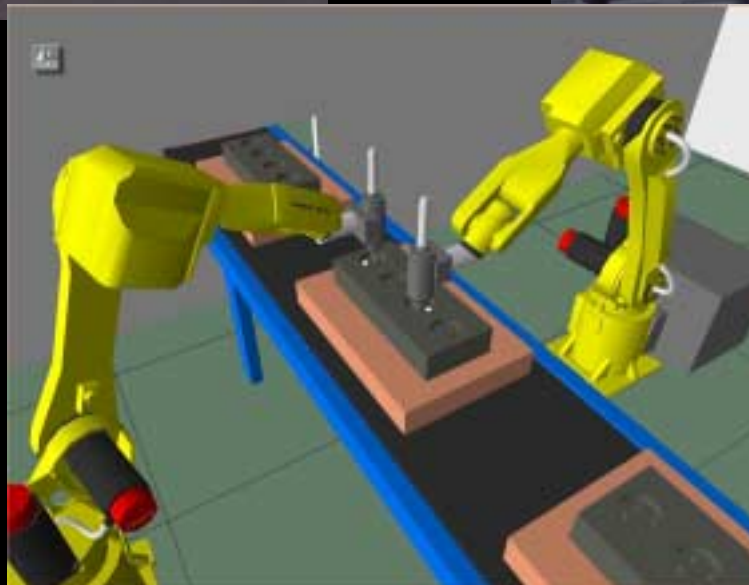
Fabrication, Reconfiguration & Restoration of complex molds, dies and functional parts



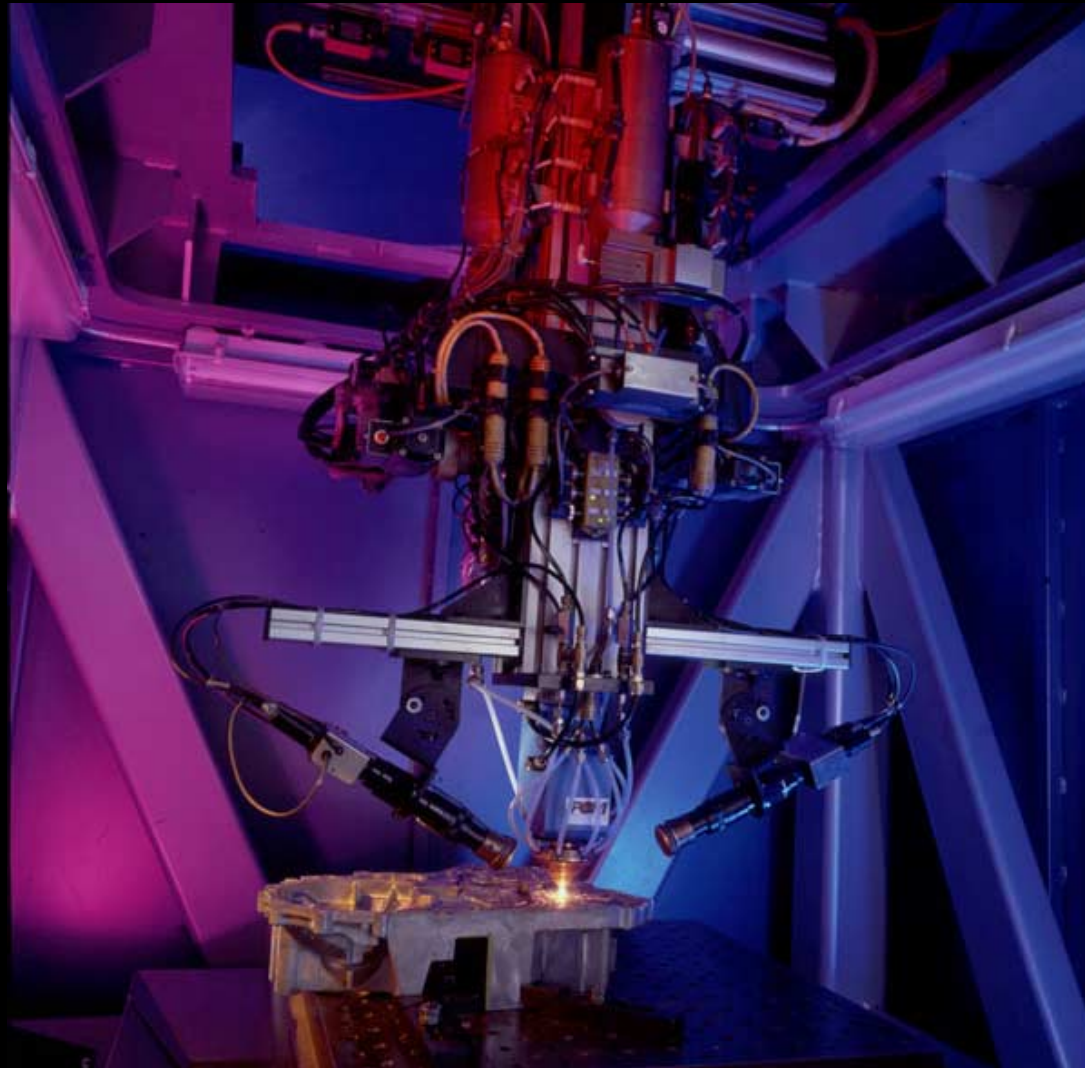
Cladding of Steel to Aluminum Parts for Hard Facing



Replacement of Press Fit Engine Valve Seats With Cladded Seats

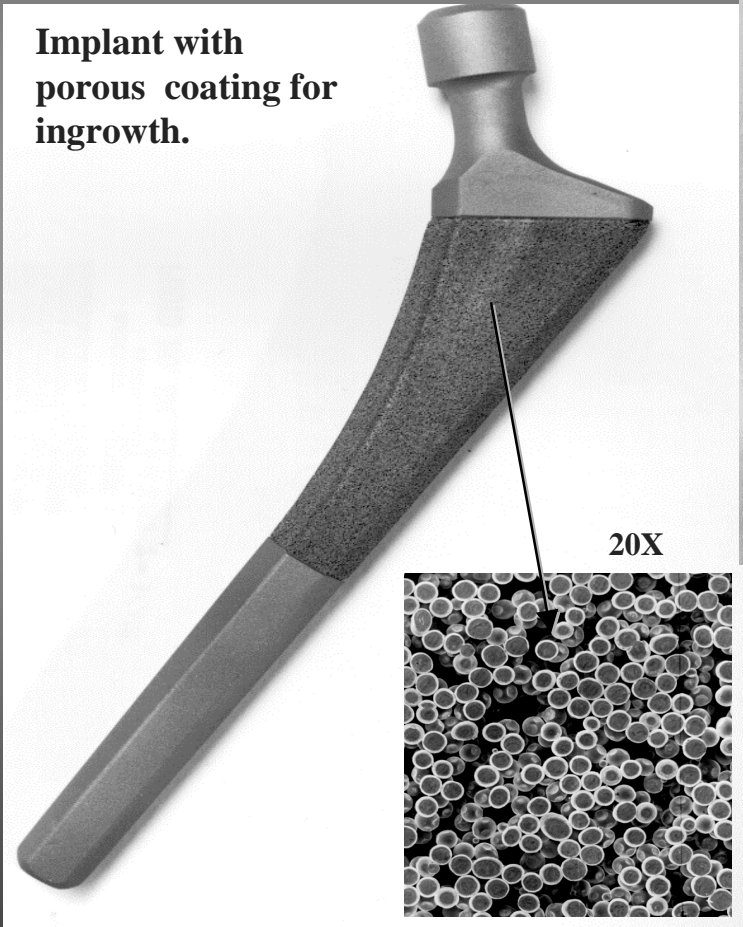


Repair of Cracked Parts

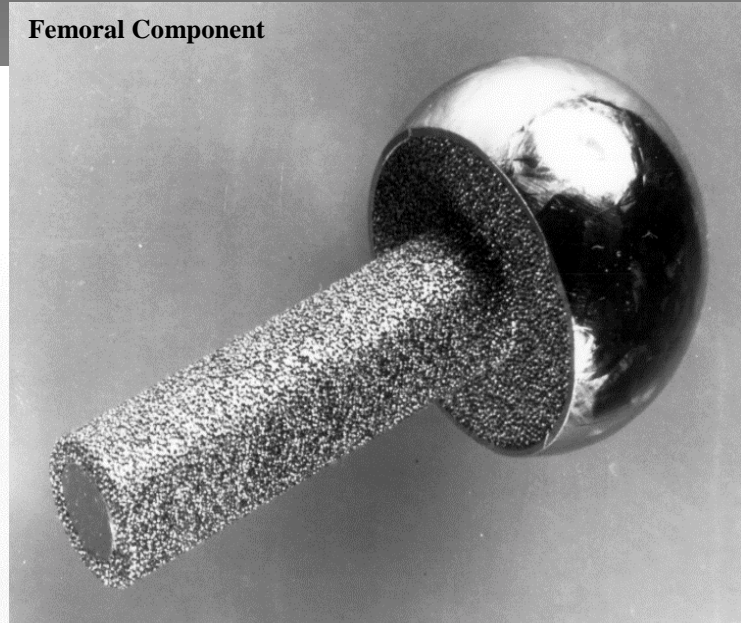


Direct Fabrication of Medical Implants

Implant with
porous coating for
ingrowth.



Femoral Component





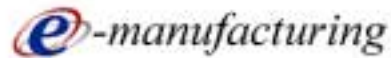
Advantages of DMD

Time compression.

- “Reconfigure” products rather than “design & build” new products due to in-process engineering changes or product improvements.
- “Restore” existing products or tooling rather than procure “new”.

POM Future Direction

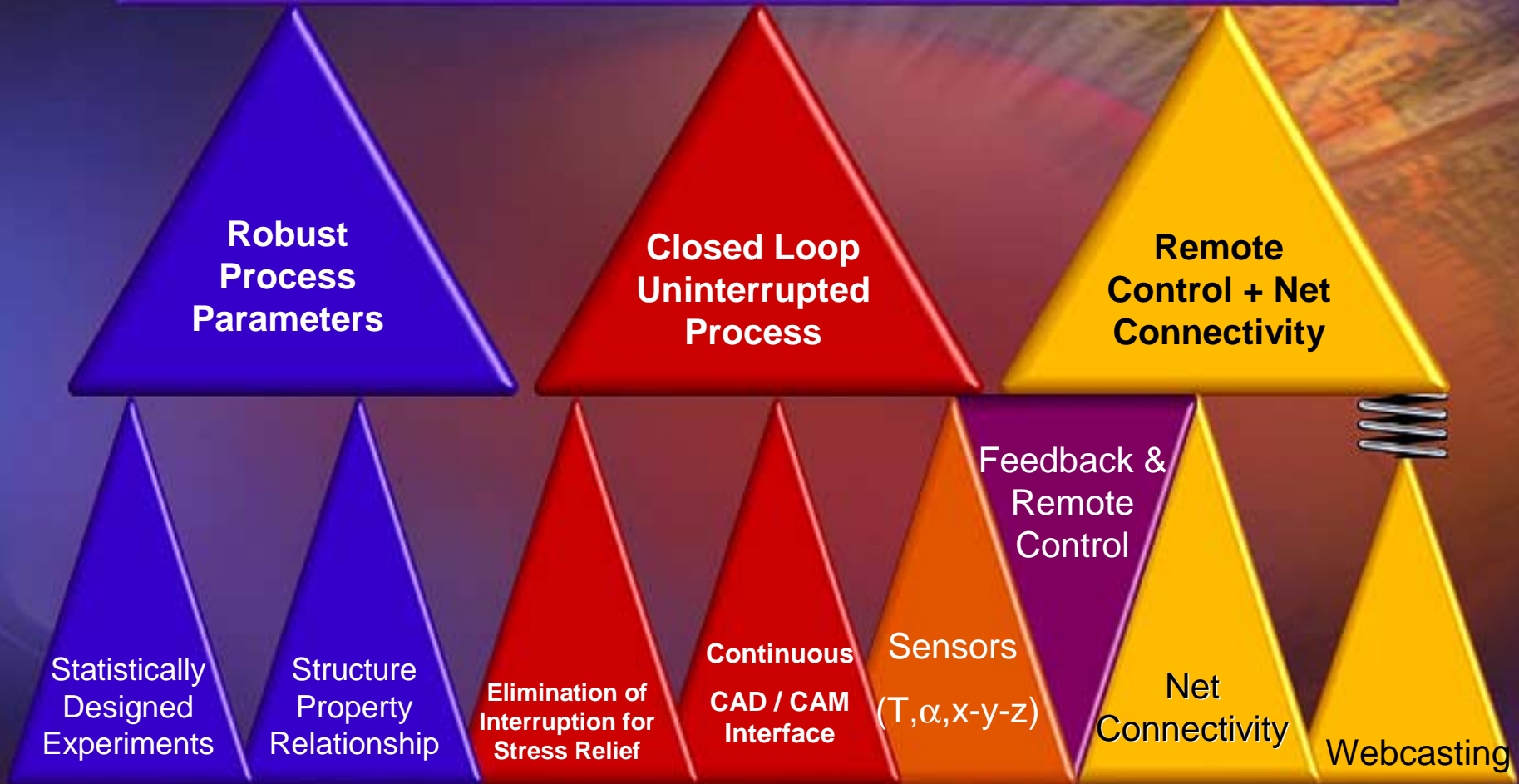
- Increase deposition rate of the process.
- Development of a portable machine.
- Test patented part/tool identification process.
- Production test rapid laminate tooling.
- Establish a global service bureau network.



The global platform for internet based remote “lights-off” manufacturing by the marriage of multiple technologies including computer networks with closed loop direct metal deposition system.



Roadmap to Lights Off DMD Manufacturing





Full Spectrum of Strategic Solutions

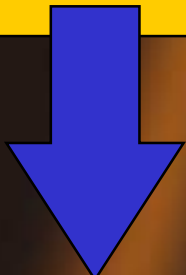
Dies



- Aluminum die casting
- RapiDIES Optimized Thermal Management



Molds



- Thixomolding
- Injection molding Cavities
- Conformal Cooling



Product Design Services



- "direct" metal rapid prototype parts



Remote Manufacturing



- Web enabled product data transfer to direct manufacturing



Production Machinery



- DMD machinery lease/rental





....A Better Way to

Fabricate....

Reconfigure....

&

Restore....

Products



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